PATENT SPECIFICATION (11) 1 491 198

1 491 198

(21) Application No. 51975/73 (22) Filed 8 Nov. 1973 (19)

(23) Complete Specification filed 25 Oct. 1974

(44) Complete Specification published 9 Nov. 1977

(51) INT. CL.[2] F01N 3/15 B01D 53/34

(52) Index at acceptance

B3A 26 51 78G 78TA

B1F 100 D1B D1C

(54) IMPROVEMENTS IN OR RELATING TO CATALYST BODIES AND METHODS OF MANUFACTURING SUCH BODIES

(71) We, UNITED KINGDOM ATOMIC ENERGY AUTHORITY, LONDON, a British Authority, do hereby declare the invention,

for which we pray that a patent may be granted to us, and the method by which it is to be performed, to be particularly described in and by the following statement:—

This invention relates to catalyst bodies and methods of manufacturing catalyst bodies which are constructed to have channels extending through them.

One way of fabricating such bodies is to lay together two or more corrugated sheets which have identical parallel corrugations, in such a way that adjacent sheets touch along their crests. It is customary to join the sheets together along the crests of the corrugations. It is, however, very difficult to position each sheet accurately relative to the other when producing such bodies on a production-line. It is particularly difficult to avoid nesting of crests of one sheet in to the valleys of an adjacent sheet. This problem is even greater in those cases where it is not possible to join the sheets together, but it is desired to maintain the sheets in contact with each other. Similarly, if a single corrugated sheet is wound upon itself to form a coil, it is difficult to prevent the crests of outer layers nesting in the valleys of the next inner layers.

One way of lessening these problems has been to bond a separate plain sheet to the corrugated sheet. In this way, the plain sheet serves as a dividing wall which prevents the crests of the corrugations of each layer nesting in to the valleys of adjacent layers when the sheets are laid up. Here again, during production it is necessary to have two sources of sheets, one of which is passed through corrugating rolls and the other not. The corrugated sheet has to be fed to the corrugating rolls at a faster rate than the speed of movement of the plain sheet so that when the sheets are brought together and joined, they are moving together at the same velocity. Since the sheets are bonded together the end product at this stage of production is fairly easy to handle and there is very little difficulty in laying up such duplex sheets to form the desired final body having voids or channels extending through it.

However, there are instances where it is not possible to join the sheets together. For example, there are cases where to do so would damage the sheet or coatings applied to the sheet. There are also instances where it is uneconomic to introduce a joining step in the production of the final article. In these instances it is difficult to lay up these duplex sheets of the prior art to fabricate the desired final body.

According to one aspect of the invention is provided a catalyst body having channels extending there-through comprising layers of corrugated material arranged with the corrugations parallel, one or more of the layers being provided with protuberances which serve to prevent the crests of one layer nesting in the valleys of the adjacent layer or layers, wherein at least one of the layers is provided with a catalyst material over at least part of its surface area.

If desired, each layer may be provided with protuberances. The protuberances may be provided by tabs formed from the flanks of the corrugations.

In the case where each corrugation has more than one tab, the tabs of each corrugation may extend in a common direction across a common adjacent valley, or one or more of the tabs may extend in the opposite direction to the other tab or tabs.

Preferably the tab or tabs of each corrugation are staggered, relative to the tab or tabs of adjacent corrugations, in a direction along the corrugations.

The layers may be formed by laying a part of a single corrugated strip on itself. Furthermore, the double layer formed by laying part of a single corrugated strip on itself may be wound upon itself to form a coil.

The layers may be formed from a single first corrugated sheet and a single second corrugated sheet at least one of which is provided with the protuberances. In this case the double layer so formed may be wound

on itself to form a coil which, progressing radially, comprises alternate layers of the first and second sheets.

Each layer may be elongate and the crests and valleys of the corrugations may extend in a direction transverse to the length of each layer so that the body has channels, defined between adjacent contiguous layers which channels extend across the layers. Alternatively, the crests and valleys of the corrugations may extend in a direction along the length of each layer so that the body has channels defined between adjacent contiguous layers which channels extend in a direction along the layers.

At least one of the layers may be perforated.

The corrugated material may be of metal, such as for example an oxidised aluminium bearing ferritic steel.

According to a further aspect of the invention there is provided a method of manufacturing a catalyst body having channels extending therethrough comprising the steps of working a first sheet of material to form a plurality of corrugations each of which comprises a crest and a valley, providing each corrugation with a protuberance extending across a valley towards an adjacent corrugation, laying a second corrugated sheet on the first sheet to form layers the corrugations of the first and second sheets being arranged parallel to one another and the protuberances being so formed that they restrain the crests of the second sheet from falling into the valleys of the first sheet, and deposting a catalytic material on at least one of the sheets.

According to a further aspect of the invention there is provided a method of manufacturing a catalyst body having channels extending through it comprising the steps of working a strip of material to form a plurality of corrugations each of which comprises a crest and a valley, providing each corrugation with a protuberance which extends across a valley towards an adjacent corrugation, forming two or more spaced first sheets from the strip of material, interposing between the first sheets a second sheet or sheets made from a corrugated strip of material to form layers, the sheets being arranged relative to one another so that the crests of the corrugations of each layer lie parallel to the crests of the corrugations of the adjacent layer or layers, and the protuberances being provided so that they restrain the crests of each layer from falling into the valleys of the adjacent layer or layers, and deposting a catalytic material on at least one of the sheets.

According to a further aspect of the invention there is provided a method of manufacturing a catalyst body having channels extending therethrough comprising the steps of working a strip of material to form a plurality of corrugations each of which comprises a crest and a valley, providing each corrugation with a protuberance which extends across a valley towards an adjacent corrugation, laying a part of the strip upon itself to form two or more layers the corrugations of the layers being arranged parallel to one another, the protuberances being so formed that they restrain the crests of each layer from falling into the valleys of the adjacent layer or layers, and depositing a catalytic material on at least one of the layers. The protuberances may be formed by punching tabs from the flanks of the corrugations.

The first and second sheets define a multilayer assembly, which may be wound upon itself to form a coil.

The two or more layers formed by laying the strip upon itself constitute a multilayer assembly which may be wound upon itself to form a coil.

The step of depositing a catalytic material may be carried out prior to, or after, forming the corrugations. In the case where the strip or sheets are made of oxidised aluminium bearing ferritic steel the step of corrugating strip or sheets may be carried out before, or after, the steel has been oxidised. It is however preferred to oxides the surface of the steel before the step of corrugating the strip or sheets, and then deposit the catalytic material on the oxidised surface of the steel after the step of corrugating the strip or sheets.

A number of embodiments of the present invention will now be described, by way of example, with reference to the accompanying drawings in which:—

Figures 1 and 2 show plan views of a strip of material worked in accordance with the present invention to provide uniform corrugations, but with different patterns of spacing tabs,

Figure 3 is a cross-section along the line xx of figure 1,

Figure 4 is a cross-section along line yy of figure 2, and

Figures 5, 6 and 7 illustrate three different bodies constructed in accordance with the present invention.

In the following examples the end products are intended for use as a catalyst in an exhaust gas purification system for an internal combustion engine. The strip is made of an aluminium bearing ferritic steel, of the type known as FECRALLOY (Trade Mark of the United Kingdom Atomic Euergy Authority) to which is applied a catalytic material, such as for example, platinum or palladium metal. A method of applying a catalyst material to a support is described in our British Patent 1,455,248 to which attention is directed. The strip is 0.002 ins (0.05 mm) thick, 4 ins (101.6 mm) wide, and of various lengths.

A length of oxidised plain strip, pre-coated with the catalyst, is corrugated by passing it through corrugating rolls (not shown). The crests 2 and valleys 3 of the corrugations extend across the strip 1. During the corrugating step one or more tags 4 are punched up on each corrugation. This is achieved by a tool (not shown) which pierces the strip to cut a substantially rectangular U shape. The tool at the same time pushes up the strip to form a tab 4.

Referring to figures 1 and 3 it will be seen that two tabs are punched up on each corrugation to form effectively two series of tabs 4 which lie along lines 6 and 7 which are parallel to the longitudinal axis 5 of the strip. All the tabs 4 extend in the same direction relative to the strip 1 and each tab 4 of each corrugation extends across a common valley towards an adjacent corrugation.

Referring to figure 2 and 4 the strip 1 has three tabs punched up on each corrugation to form effectively three series of tabs 9, 10 and 11 which lie along parallel lines in a similar manner to the tabs 4 of figure 1. The tabs 10 that are positioned intermediate the tabs 9 and 11 extend in the oposite direction to the tabs 9 and 11.

There are many variations that can be made to the pattern of the positions of the tabs 4, 9, 10 or 11 relative to the strip 1. For example, alternate corrugations may be provided with two or more tabs, at least one of which extends in the opposite direction to the other tab or tabs, in this way, whilst the tabs are only pushed out on alternate corrugations at least one tab extend across each valley of the complete series of corrugations.

Furthermore, the tabs may be arranged to extend across the valleys on one side of the strip and not across the valleys on the other side of the strip. Alternatively, tabs may be arranged so that each valley on each side of the strip has at least one tab extending across it.

The position of the tabs may be staggered in a direction along the crests of the corrugations or the sets of tabs may be at the same location along the crest of each corrugation.

Referring to figure 5, the strip 1 fabricated with tabs as described above, is cut into discrete lengths and each sheet so formed is laid up on to an identical sheet to form two or more layers of corrugated sheets. Alternatively, a continuous length of the strip of figure 1 or figure 2 may be folded in a zigzag manner about transverse axes spaced along the strip to bring a second layer of the strip on to the first layer. The layers so formed may be held together by encasing them in a can which leaves the ends of the sheets exposed. The multilayer assembly so formed may be wound upon itself to form a coil, which progressing radially, comprises successive laps of the multilayer assembly.

In an alternative route for manufacturing a body, a continuous length of the strip of figures 1 and 2 may be wound on itself to form a coil as shown in figure 7. This may be achieved by winding the strip 1 from one end and tightly coiling it on itself, care must be taken however to avoid damaging the corrugations during the winding step.

In yet a further way of manufacturing a body in accordance with the present invention, instead of providing each layer with tabs 4, 9, 10 and 11, each alternate layer may be a corrugated sheet which does not have tabs punched up. Such an arrangement is shown in figure 6 where the sheets 13 have tabs, but the sheets 12 do not. Here again the layers so formed are held together by encasing them in a can 14 which leaves the ends of the sheets exposed. Here again the multilayer assembly so formed may be wound upon itself to form a coil which, progressing radially, comprises successive laps of the multilayer assembly.

In all of the arrangements described above, the tabs 4, 9, 10 and 11 form a spacing member which prevents the crests of corrugations of one sheet falling into the valleys of the corrugations of the adjacent sheet. It may be advantageous to form the tabs as close to the crests of the corrugation as possible, and to ensure that each tab extends across the adjacent valley and leaves only a small gap between the end of each tab and the adjacent crest which is insufficient for the crests of adjacent layers to nest into. In this way the crests of the corrugations of adjacent layers are less likely to nest in the gap between the end of the tabs and the adjacent crest. Furthermore, a more even layering is likely to result if the difference in height between the crests and the tabs of each layer and the gaps between the tabs and adjacent crests are kept as small as possible, because in this case, it does not make much difference if the crests of adjacent layers rest on the crests, tabs, or in the gaps of the next adjacent layer.

The cross-sectional shape of the corrugations may be of any desired form. For example, it may be a succession of alternate inverted and non-inverted "V" or "U" shapes or rectangular channels or may be of a sinusoidal form.

The strip may be coated with power prior to applying the catalyst to extend the surface area of the strip. Alternatively, the surface of the strip may be roughened prior to applying the catalyst to achieve the same aim.

WHAT WE CLAIM IS:—

1. A catalyst body having channels extending therethrough comprising layers of corrugated material arranged with the corru-

gations parallel, one or more of the layers being provided with protuberances which serve to prevent the crests of one layer nesting in the valleys of the adjacent layer or layers wherein at least one of the layers is provided with a catalyst material over at least part of its surface area.

2. A body according to claim 1 wherein only alternate layers are provided with the protuberances.

3. A body according to claim 1 or claim 2 wherein the protuberances are provided by tabs formed from the flanks of the corrugations.

4. A body according to claim 3 wherein each corrugation has more than one tab, and the tabs of each corrugation extend in a common direction across a common adjacent valley.

5. A body according to claim 3 wherein each corrugation has more than one tab, and one or more of the tabs extend in the opposite direction to the other tab or tabs.

6. A body according to claim 3 wherein the tab or tabs of each corrugation are staggered relative to the tab or tabs of adjacent corrugations in a direction along the corrugations.

7. A body according to any one of claims 1 to 6 wherein the layers are formed by laying a part of a single corrugated strip on itself.

8. A body according to any one of claims 1 to 7 wherein the layers are formed by laying part of a single corrugated strip on itself and the double layer so formed is wound upon itself to form a coil.

9. A body according to any one of claims 1 to 6 wherein the layers are formed from a single first corrugated sheet and a single second corrugated sheet at least one which is provided with the protuberances, and the double layer so formed is wound on itself to form a coil which, progressing radially, comprises alternate layers of the first and second sheets.

10. A body according to any one of claims 1 to 9 wherein each layer is elongate and the crests and valleys of the corrugations extend in a direction transverse to the length of each layer so that the body has channels, defined between adjacent contiguous layers which channels extend across the layers.

11. A body according to any one of claims 1 to 9 wherein each layer is elongate and the crests and valleys of the corrugations extend in a direction along the length of each layer so that the body has channels defined between adjacent contiguous layers which channels extend in a direction along the layers.

12. A body according to any one of the preceding claims wherein at least one of the layers is perforated.

13. A body according to any one of the preceding claims wherein the corrugated material is of metal.

14. A body according to claim 13 wherein the metal is an oxidised aluminium bearing ferritic steel.

15. A body according to claim 14 wherein a catalytic material is provided on at least part of the oxidised surface of the aluminium bearing ferritic steel.

16. A method of manufacturing a catalyst body having channels extending therethrough comprising the steps of working a first sheet of material to form a plurality of corrugations each of which comprises a crest and a valley, providing each corrugation with a protuberance extending across a valley towards an adjacent corrugation, laying a second corrugated sheet on the first sheet to form layers, the corrugations of the first and second sheets being arranged parallel to one another and the protuberances being so formed that, they restrain the crests of the second sheet from falling into the valleys of the first sheet, and depositing a catalytic material on at least one of the sheets.

17. A method of manufacturing a catalyst body having channels extending through it comprising the steps of working a strip of material to form a plurality of corrugations each of which comprises a crest and a valley, providing each corrugation with a protuberance which extends across a valley towards an adjacent corrugation, forming two or more spaced first sheets from the strip of material interposing between the first sheets a second sheet or sheets made from a corrugated strip of material to form layers, the sheets being arranged relative to one another so that the crests of the corrugations of each layer lie parallel to the crests of the corrugations of the adjacent layer or layers, and the protuberances being provided so that they restrain the crests of each layer from falling into the valleys of the adjacent layer or layers and depositing a catalytic material on at least one of the sheets.

18. A method of manufacturing a catalyst body having channels extending therethrough comprising the steps of working a strip of material to form a plurality of corrugations each of which comprises a crest and a valley, providing each corrugation with a protuberance which extends across a valley towards an adjacent corrugation, laying a part of the strip upon itself to form two or more layers the corrugations of the layers being arranged parallel to one another, the protuberances being so formed that they restrain the crests of each layer from falling into the valleys of the adjacent layer or layers, and depositing a catalytic material on at least one of the layers.

19. A method according to claim 16 or

claim 17 wherein the protuberances are formed by punching tabs from the flanks of the corrugations.

20. A method according to claim 16 or claim 17 wherein the multilayer assembly defined by the first and second sheets is wound upon itself to form a coil.

21. A method according to claim 18 wherein the multilayer assembly defined by the layers is wound upon itself to form a coil.

22. A method according to claim any one of claims 16 to 21 wherein the step of depositing a catalytic material is carried out prior to forming the corrugations.

23. A method according to any of the preceding claims 16 to 22 wherein the strip or sheets are made of oxidised aluminium bearing ferritic steel and the step of corrugating the strip or sheets is carried out after the steel has been oxidised.

24. A method according to claim 23 wherein a catalytic material is deposited on to the oxidised surface of the steel before forming the corrugations.

25. A method according to claim 23 wherein a catalytic material is deposited on the oxidised surface of the steel after the step of forming the corrugations.

26. A method of manufacturing a catalyst body substantially as herein described with reference to the accompanying drawings.

27. A catalyst body substantially as herein described with reference to the accompanying drawings.

K. LEAMAN,
Chartered Patent Agent.
Agent for the Applicants.

Printed for Her Majesty's Stationery Office by Burgess & Son (Abingdon), Ltd.—1977.
Published at The Patent Office, 25 Southampton Buildings, London, WC2A 1AY,
from which copies may be obtained.

1491198 COMPLETE SPECIFICATION
2 SHEETS *This drawing is a reproduction of the Original on a reduced scale*
Sheet 1

FIG.1.

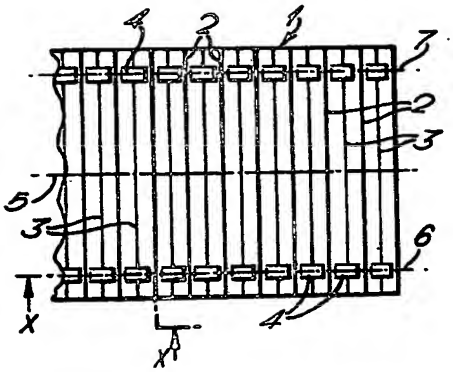
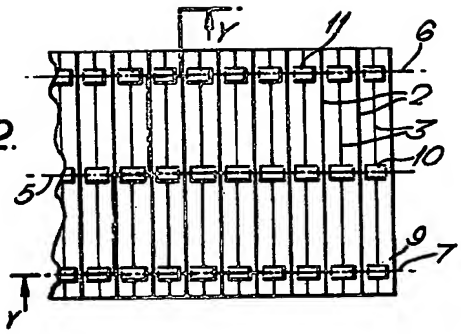


FIG.2.



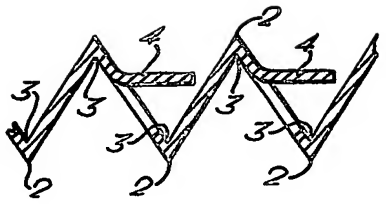


FIG.3.

1491198 COMPLETE SPECIFICATION
2 SHEETS *This drawing is a reproduction of the Original on a reduced scale*
Sheet 2

FIG. 4.

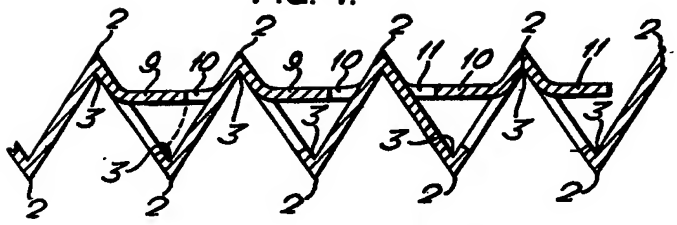


FIG. 5.

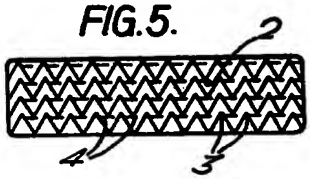
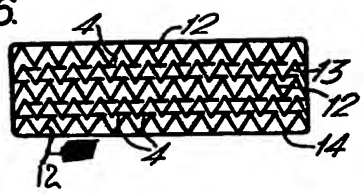


FIG. 6.



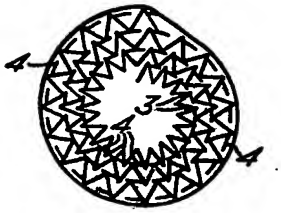


FIG. 7.